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BLOOM TAXONOMY ON TECHNOLOGY-TRANSFER ON AGRICULTURE IN INDONESIA

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ABSTRACT

One of the problems in the agricultural sector in Indonesia is the increasing proportion of old farmers compared to young farmers which lead to the inefficient utilization of some appropriate new technology. This is exacerbated by the small land per farmer so the application of innovation becomes incompetent to compare to an area with a wide stretch of land with bigger land ownership per farmer.

On the other side, the era of the industrial revolution 4.0 is non-negotiable with the increasing number of world population compared to agricultural land which is increasingly having time. The crisis caused by the COVID-19 pandemic has decreased people's purchasing power so that the price of food products is expected to be sold at affordable prices.

This paper provides an alternative solution regarding the process of transferring technology 4.0 from public funding research institute in the agricultural sector using the Bloom Taxonomy approach. It shows that critical position for agricultural workers and farmers to have the sense of urgency and sense of ownership of new technology

Keywords: Agriculture, Agricultural Human Resources, Bloom Taxonomy, Sense of Ownership, Sense of Urgency, Technology Transfer &Technology 4.0

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Original Article

1. INTRODUCTION

The agricultural sector is an important part of the Indonesian economy. Adjustments in agricultural activities are influenced by technology. With the number of people who continue to increase and agricultural land is decreasing, technology is an important alternative in meeting food needs. Research on biotechnology research clusters has a lot of influence in offering solutions to problems through gene technology (*genetic modified*) to cloning.

The oldest gene modification occurs naturally as indicated at Gobleki Tepe in Tunisia around 700 BC. The modifications that occur are caused by the contribution of insects and wind to the plants of the Oryza family (grains). The process that occurs causes the grains in the grass that do not fall easily to the ground. This grain can finally be harvested and become food ingredients. The modification of genes in plants and becoming food plants does not only produce rice and wheat. In its development, natural gene modification also occurs in many plants such as bananas, cassava, and tomatoes. Bananas consumed by humans are currently gripped in size where the first generation of bananas was about the size of a finger with seeds. So, In the past, cloning technology has become an option.

The faster development of livestock means more animals can be produced in one year. Cloning technology produces livestock according to the expected product. As in the dairy cow cloning, what is being developed is a cow that can produce a lot of milk. It is not necessary whether the person will be fat or have strong bones.

The trend of technological development is in favor of the biotechnology family. In the early 1970s, technological developments were expected to occur in the space technology sector. So that the development of technology for satellites, space shuttle occurred at this time. However, in its development, the most influential technology is that which is directly related to human life on earth, namely biotechnology such as food and health

The dynamics of the agricultural world cannot be separated from the environment outside agriculture. The development of digital technology, which has previously occurred in the manufacturing sector, has penetrated agriculture. The planting process on large plantations is gradually (incremental) starting to adopt digital technology. For example, the use of satellites in determining the harvest period for oil palm. Likewise, in the treatment, harvesting, and handling of waste generated from the processing of palm oil.

The important role of the agricultural sector should form a strong bargaining power of farmers in the supply and demand market. Supposedly, with the magnitude of the influence of the agricultural sector on people's lives, bargaining power, and farmers' welfare should increase. This is accommodated in the new Employment Creation Law that was passed. This law revises regulations on the agricultural, investment, import, and land-use sectors aimed at ranking the country's ease of doing business and increasing food security.

The Job Creation Law changes at least 3 laws that regulate the agricultural sector, Law no. 39/2014 on plantations, Law No.13 / 2010 on horticulture, Law no. 18/2012 concerning food and Law no. 41/2009 concerning the protection of sustainable agricultural food land. In the horticultural sector, this law removes the 30% limit on foreign investment. The fulfillment of basic foodstuffs is still a problem. Indonesia plans to import 266,374 tons of garlic and 241,494 tons of beef by 2021 (Ministry of Trade 2020). The level of dependence on wheat is 100% in the first rank, followed by a level of import dependence of 93.7% for garlic. Agricultural efficiency is a major problem that causes the government to open up greater foreign investment opportunities and facilitate imports of food and foodstuffs. The second problem with agriculture is population growth, thereby expanding residential areas and narrowing agricultural land. There was a decrease in the area of agricultural land from 2013 of 7.75 million hectares to 7.46 million hectares in 2019.

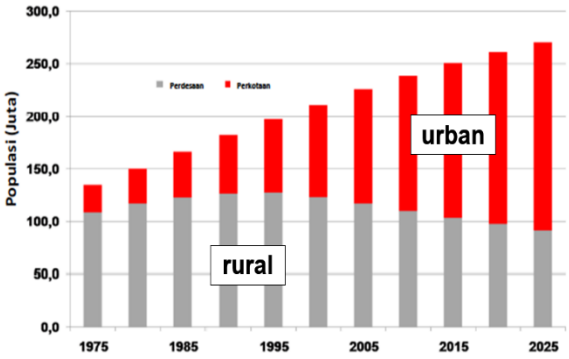

Figure 1: The Trend of Rural Workforce.
Source: Fitrianatsany, 2017

The decline in land area is also what is driving the number of agricultural workers. In 1974 the ratio of agricultural workers was 5 times the number of urban workers. This trend is different from 2015 with agricultural workers who accounted for almost half of urban workers (Fitrianatsany, 2017)

2. LITERATURE STUDY

A. Technology Diffusion

Technology diffusion is the process of innovation by communicating technology through a flow that is following the character of technology to reach target users in a time-limited social system. (Bessant, 1999; Bozeman, 2000; Kumar et al., 2015). Technology diffusion in a narrow sense is defined as the process of transferring technology from one to many potential users. The process that occurs is part of technology transfer where technology transfer starts from the conception of ideas to technology that is ready to be transformed into products that are ready to be developed by other actors who play a role in manufacturing. Products developed from this technology are ready to be made on a larger scale according to the capacity demand. Meanwhile, diffusion will be in the middle of the process with the technology status that is ready for production.

Communication is carried out by technology diffusion through various channels (channels of communication) that are tailored to the character of the product and its target market. Medical device products are not used by general consumers as end-users. Meanwhile, food technology that develops bacteria for the fermentation of gluten-free food products will have a direct relationship with household users as end consumers. Communication channels on medical device products are different from food products. Two other elements that influence the diffusion of technology are the characteristics of the end-user and the scale of use of the product. The end-user of a research technology is not always a household user. In the constellation of technology diffusion, the results of research from an R & D can be an important part for other actors such as universities or R & D. Such as the research results of Xanthan Gum from the Xanthomonas Campestris bacteria from a work unit in government R&D which is an important part of an experiment in a food technology study program. From here, it will require processing and testing if it will be transferred to households as end-users as non-gluten food.

The digital technology referred to in this paper is an electoral tool used in the agricultural sector for the planning, storing and utilizing agricultural data through online media, multi-media and communication tools based on Android or the iPhone Operating System (IOS). Digital technology changes people's behavior in interacting and making transactions (Carlsson, 2004; Jackson et al., 2002; Miller & Wilsdon, 2001). This technology is used by modern agriculture to get a more efficient way of working with accurate data measurement.

B. Smart Farming

Cultivate agriculture to suit the contours of the land and plants that will be cultivated. The continent of Australia with the largest part of it is the mainland has formed agriculture with large areas owned by farmers which are often referred to as ranch. In a broad expanse, the equipment used is also used to do agriculture for large areas, for example, the use of airplanes for watering and large tractors for land preparation. In contrast to Indonesia, where the largest part is the sea, the agricultural land owned by farmers is much smaller than the land owned by farmers in Australia. In preparing paddy fields, for example, the use of mini plod tractors is commonly used. The land comparison can be projected from the mechanization level as follows

Table 1: Level of Mechanization and Average Land Ownership

Level of Mechanization		Average Land Ownership by Farmers	
USA	: 17 hp/ha	Indonesia	: 0.80 ha
Japan Malaysia	: 16 hp/ha	Japan	: 1.57 ha
Thailand	: 2.4 hp/ha	South Korea	: 1.46 ha
Vietnam	: 2,5 hp/ha	Philippine	: 2.00 ha
	: 1.5 hp/ha	Thailand	: 3.2 ha
Source: Harsono, 2020			

The level of mechanization is the area of land with the availability of agricultural machinery. The table shows that the ratio of the level of mechanization in America is the highest, namely 17 hp/ha. In one hectare of agricultural land using 17 agricultural tools. The level of mechanization in Indonesia moved from 0.22 in 2015 to 0.83 in 2016, 1.18 in 2017 and 1.68 in 2018. Increasing the level of mechanization shows that the availability of agricultural machinery is getting better. However, this availability is also influenced by the average land ownership of farmers. Indonesia is a country with the smallest average farmland of 0.8 ha. With a relatively narrow land area, it may be too expensive to use an unmanned tractor or satellite.

Research produced for the agricultural sector is also the highest, namely as many as 13 technology products consisting of 9 prototype technologies and 4 which are already in the application stage (Febrianda et al., 2020). The second sector after agriculture is the information and communication sector with 2 technology prototypes and 3 technologies that have been utilized.

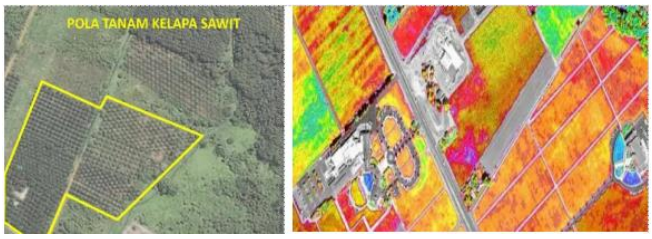

Figure 2: Utilization of Satellite Imagery in Oil Palm Plantations.
Source: (Harsono, 2020)

In the view of smart agriculture, equipment with electronic capacity and the internet is an important part. Such as the use of satellites to monitor pests on agricultural land in Australia. Oil palm fields in Sumatra use satellites to find out groups of oil palm trees that are ready to be harvested. The use of artificial intelligence-based remote-controlled tractors is also an option for large farms. Smart farming that can be done on narrow lands in Indonesia is the automation of agricultural tools and machines.

3. BLOOM TAXONOMY: DIFFUSION STRATEGY ON DIGITAL TRANSFORMATION ON AGRICULTURE

The transition from technology as a research result to the product and commercialization required a distinctive process that would be differentiated by the character of the product, consumers and the price. While in the case of agriculture, most of the new technologies relating to the application of agricultural tools, fertilizer and feed are different from consumer goods. New technology required a comprehensive understanding of using those products. The transferor of technology should be able to give the knowledge the motivation of using and benefit of using new technology.

Bloom taxonomy as an approach to transferring knowledge is relevant in this field. Based on that case, it is recommended to observed a literature study on technology transfer and Bloom Taxonomy. Based on the result using Mendeley Apps, showed 514 articles from 2008 to 2014 with the keywords. The density of relation analyzed using VOS viewer as followed:

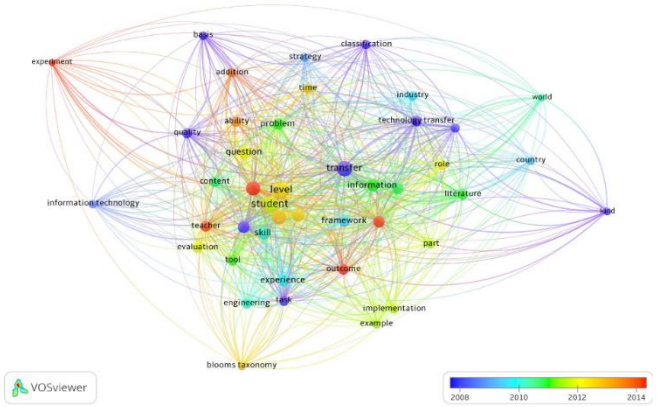

Figure 3: Vos Viewer Result on Technology Transfer and Bloom Taxonomy.

More articles on Bloom taxonomy are in the education field as such increasing the capacity of students and experiment of capturing the knowledge of information technology. Consequently, it is in the education field with includes teaching, student and stakeholders. The transition from research, prototype and product is equipped with an introduction to incumbent users. This process should include knowledge transfer so the potential users are not only understand how the product works but they understand that the product is their needs.

Farmer in rural areas of developing countries relies upon the old tradition while the researcher and student located in the neighbor town. Agricultural extensions play an important role in technology transfer which should be involved since the beginning of utilizing a new technology.

We take the opportunity to discuss how technology transferring in Australia with Kim Bryson from the University of Queensland Australia in 2007. She implied a different approach in transferring technology based on the kind of agricultural product. Walking The Chain was one of an approach to transferring knowledge to Aboriginal Tomatoes Growers. The farmer had been introduced to the tomatoes supply chain. They observe their product along the way to the seller.

The transferor needs to limit the transfer process to avoid a dependency syndrome where the transferee will continue to depend on the transferor for coaching and budget for the product. Dependency syndrome can be indicated by the change in the object of the perpetrator of a project. In an agricultural technology exhibition, for example, tenants who are included in the exhibition appeared. Picking the winner usually occurs due comfortability of the transferor that no longer needs to provide coaching and administration substance to the Newbie.

Bloom's Taxonomy was founded in 1956 by Dr. Benjamin Bloom to facilitate the teaching process in education. Students are expected to previously rely on rote learning on the ability to remember and evaluate concepts, processes, procedures and philosophy.

There are three domains in educational activities based on Bloom, namely:

- Cognitive: mental capacity (knowledge)
- Affective: Growth of awareness and emotions (attitude)
- Psychomotor: awareness of physical capacity (skills)

The cognitive domain consists of knowledge and intellectual capacity development such as remembering and recognizing objects, patterns, procedures and concepts. There are 6 categories of a cognitive process.

Table 2: Knowledge Domain In Bloom's Taxonomy

Category	Categories Examples, Keywords (verbs), and Technology for Learning (Activities)
Remembering: Remember or retrieve previously learned information.	**Example**: Read policies. Quote price from memory to customer. Read the safety rules. **Keywords**: define, explain, identify, know, label, list, match, name, outline, recall, recognize, reproduce, elect, state **Technology**: bookmarking, flashcards, rote learning by repetition, reading
Understanding: Understanding the meaning, translation, interpolation, and interpretation of instructions and problems. Express the problem in one own word.	**Example**: Rewrite test writing principles. Describe in your own words the steps for performing a complex task. Translate the equations into a computer spreadsheet. **Keywords**: understand, convert, defend, differentiate, estimate, explain, expand, shade, give examples, conclude, interpret, paraphrase, predict, rewrite, summarize, translate **Keywords**: understand, convert, defend, differentiate, estimate, explain, expand, shade, give examples, conclude, interpret, paraphrase, predict, rewrite, summarize, translate **Technology**: making analogies, participating in cooperative active learning, taking notes, storytelling, internet searches
Applying: Use a concept in a new situation or use an unprompted abstraction. Applying what is learned in the classroom to new situations at work	**Example**: Use a manual to calculate employee vacation time. Apply statistical laws to evaluate the reliability of written tests. **Keywords**: apply, change, computation, construction, show, discover, manipulate, modify, operate, predict, prepare, produce, relate, shows, solve, use **Technology**: collaborative learning, creating processes, blogs, practices
Analyzing: Separating material or concepts into parts so that the organizational structure can be understood. Distinguish between facts and conclusions.	**Example**: Solve a piece of equipment problem using logical subtraction. Recognize logical fallacies in reasoning. Gather information from departments and select tasks required for training. **Keywords**: analyze, break down, compare, contrast, diagram, deconstruct, differentiate, differentiate, differentiate, identify, illustrate, conclude, outline, relate, choose, separate **Technology**: Fish Bowls, argue, question what's going on, run tests.
Evaluating: Making judgments about the value of an idea or material	**Example**: Choose the most effective solution. Hire the most qualified candidates. Describe and appreciate the new budget. **Keywords**: assessment, comparing, concluding, contrasting, criticizing, criticizing, defending, describing, discriminating, evaluating, explaining, interpreting, justifying, narrating, summarizing, supporting **Technology**: surveys, blogging

Creating: Arranging structures or patterns from various elements. Bring the parts together to form a whole, with an emphasis on creating new meaning or structure.	**Example**: Write a company operation or process manual. Design machines to perform specific tasks. Integrate training from several sources to solve problems. Revise and process to improve results. **Keywords**: categorize, combine, rearrange, compile, create, design, design, explain, produce, modify, organize, plan, revise, rewrite, summarize, inform, write. **Technology**: create new models, write essays, network with others
Source: Bloom, 2001	

The age structure in the agricultural sector is carried out from generation to generation. Modifications made are by trial and development (trial and error). Opinions and recommendations from outside parties are treated in addition to not prioritizing changes. Several cases in increasing the capacity of farmers through technology in bio-hydro development, cattle feed silage, solar energy (solar panels) and geothermal power show insufficient understanding to make a transition to a new way.

Geothermal utilization in Cepu (East Java) was carried out to provide electricity in remote areas in 2003. This activity was enriched by increasing income for farmers by developing mushroom cultivation. Mushroom kumbung (the building that is made of Styrofoam or zinc material to maintain the isolation of fungus seeds) facilities are provided and it is hoped that the community can enjoy electricity from geothermal energy and get additional income through mushroom cultivation. Plumbing maintenance is not as simple as training. Cultivation of mushrooms which requires high hygiene in seed sorting also leads to crop failure. The mushrooms that should be able to generate income turn into mush on the straw.

However, this achievement did not last long after the government's technology transfer project was completed. The pipes were no longer used and the mushroom kumbung was turned into a storehouse for agricultural tools. And villages were back to dark.

Based on Bloom's Economics, what needs to be shifted initially is the capacity to recognize problems and define solutions. When a solution is offered by a technology provider without being given the ability to recognize the technology and the problems at hand, the solution is considered not an important part (not-invented-here syndrome).

The first domain is done through technology dissemination by researchers where there is communication between farmers as potential users of technology and researchers as technology providers. The form of the meetings held is influenced by the traditions and customs of the local community. The proper method of dissemination for fishing communities will be different from technology dissemination for rice farmers, for example. At the same place in the coastal area, dissemination of the same technology will be carried out in different ways between fishermen and fishermen's wives.

Researchers, Entrepreneurs and Farmer Representatives

A group of the farmer in technology dissemination session

Figure 4: Three-Party on Technology Dissemination.

Village officials such as village heads, farmer group leaders and agricultural extension officers play an important role in technology dissemination. To them, the initial communication was made before the farmers. In this initial communication, the form of the meeting, the target of the meeting and the object to be targeted were conveyed. Communication at this initial meeting, each actor knows each other and understands the features and specifications of technology.

Understanding in the second domain, transferors begin to get an understanding of the advantages of technology and realize that this new technology is a solution to the problems it faces. In this domain, researchers, farmers, and buyers of agricultural products are meeting. A series of meetings will be held to determine the agreement on the selling price, the quality of the products produced and the length of the process. During this period the agreement was made witnessed by the regional authority and was still lenient. Sanctions determined for default are not emphasized and the target to be achieved is the ability of farmers to use their new technology. Adjustments to the production line that are made will change the way of working that has become a tradition of farmers before.

The problem that occurs is the mismatch in the quality and quantity of the product produced which also affects the agreed time limit. Bargaining will occur to obtain a price adjustment that does not cause too much harm to both parties.

The second domain after farmers can recognize and construct problems and alternative solutions following the technology offered then is an understanding of the technology to be used. Farmers can distinguish between the technology offered and other technologies. This understanding leads to the proper use of technology.

The third domain is the psychomotor capacity in which farmers are aware that they will use existing technology as part of their work. Farmers can compare the advantages and disadvantages of new technology with those that have been used previously.

Benchmarking is one part of the fourth domain, namely evaluation. The measurement of production yield and efficiency is carried out by farmers as a basis for consideration for perfecting the new technology. In this domain, farmers begin to feel ownership. This ownership is important as a basis for refining technology in the production process so that it can be adapted to the business environment and work.

The improvement of technology adapted to the environment is part of the fourth domain (analyzing). This is important for farmers as users of new technology so that its use is sustainable. Improvements should be made by technology users and researchers can provide input by providing security limitations. Improvements may be dangerous without guidance from researchers. As in the silage dry feeding technology for farmers in the savanna area. Modifications

to the tools carried out by breeders resulted in unhygienic silage products which caused diarrhea in the cows they raised.

The fifth domain, creating, is possible if the modifications made result in a new form of the technology used. However, it is not always necessary to create new ones, most often simple modifications of the innovation.

CONCLUSIONS

Technology transfer should not only consider technology as central but involves users and stakeholders.

The application of new technology that is applied to micro-scale agricultural communities should go through a transition process that is acceptable to local traditions. Senses of ownership of innovation will help its implementation properly and sustainably.

Modification of a technological innovation carried out by the local community is an appropriate technology application that benefits every actor and agency in the innovation ecosystem.

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